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Blasting Caps with Printed Circuit Bridge

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7 Claims

This invention relates to new electric blasting initiators. More specifically, it relates to electric blasting initiators or caps having a new type of ignition bridge element.

Electric blasting initiators or caps are well-known in the art and commonly consist of a cup-shaped metallic shell, a compressed explosive charge disposed within the bottom portion of said shell to provide detonation, preferably a priming charge disposed above said explosive charge, an ignition assembly supported by the top portion of said shell and consisting of a fine bridge wire surrounded by an ignitable composition and held in place by two lead wires running through a flexible non-conductive plug around which the top portion of the shell is crimped securely, and, if desired, a delay element positioned between said ignition assembly and said explosive charge or said priming charge if the latter is present, to introduce a time lag between the passage of electric current through said igniter and the detonation of said explosive charge. This delay element normally contains some type of fuse powder, or other ignitable composition which has a definite burning rate.

At present the above mentioned ignition assembly is difficult to manufacture with a desirable degree of uniformity with respect to the resistance of the bridge wire, the resistance at the junction of the bridge wire to the lead wires and the thermal contact between the ignitable composition and the bridge wire. These variations are particularly undesirable where blasting caps are used in series detonation since they may lead to premature firing of a blasting cap thereby breaking the series circuit and leaving some of the caps undetonated.

In addition the temperature of a particular bridge wire is dependant on the current flowing through it, the resistance of the wire and on heat losses. This resistence is a function of the cross-sectional area of the wire and of its length. Thus for a given electrical supply the temperature can be increased by reducing either the diameter of the wire, or its length, or both. Decreasing the diameter lowers the strength of the wire, while decreasing the length is unsatisfactory since it is difficult to reproduce the wire in uniform short lengths.

Moreover, the present lead wire-bridge wire assemblies do not permit more than one conducting path to be made between the lead wiresthus failing to provide an alternate path for the firing current when used in a series circuit. It is also impossible with the present lead wire-bridge wire assemblies to avoid loss of heat between the bridge wire and the lead wires, this heat loss reducing the ignitive heating efficiency of the bridge wire.

It is an object of this invention to overcome the aforesaid drawbacks by providing a new type of ignition bridge element which, by automatic or semi-automatic means, may be readily produced and assembled into blasting caps.

Other objects will appear from the description of the invention which follows.

According to the present invention a new and improved electric blasting cap is provided which consists of a cup-shaped metallic shell, a compressed explosive charge disposed within the bottom portion of said shell to provide detonation, preferably a priming charge disposed above said explosive charge, an ignition assembly supported by the top portion of said shell and consisting of a printed circuit bridge positioned between and connected to two lead wires running through a flexible non-conductive plug around which the top portion of said shell is crimped securely, an ignitable composition in intimate contact with said printed circuit bridge, and, if desired, a delay element positioned between said ignitable composition and said explosive charge or said priming charge, if the latter is present, to introduce a time lag between the passage of electric current through said igniter and the detonation of said explosive charge.

The invention will be more fully understood by reference to the accompanying drawings wherein:

Fig. 1 shows a longitudinal sectional view of the blasting cap of this invention;

Fig. 2 shows an enlarged perspective view along the line 2—2 of Fig. 1 of the printed circuit bridge attached to the lead wires, and

Fig. 3 to 10 show plan views of various configurations of the printed circuit.

Referring to Fig. 1, 1 is the cup-shaped metallic shell containing within its bottom portion the compressed explosive charge 2. 3 represents the primer charge disposed above the explosive charge 2, and 4 represents the ignitable composition in intimate contact with the printed circuit bridge 5. The printed circuit bridge 5 is soldered or welded to the terminals of the two lead wires 6 and 7 which run through the flexible non-conductive plug 8 around which the top portion of the shell 1 is securely crimped as at 9.

In Fig. 2, the printed circuit bridge 5 is shown in enlarged perspective as attached to the terminals of the lead wires 6 and 7. The circuit is shown as 10 printed on the insulating surface 11.

Any of the well known techniques of manufacturing printed circuits may be used for producing the printed circuit bridge of the blasting cap of this invention, viz. painting, metal vacuum deposition of metals, foil etching etc. The foil etching technique is particularly suitable.

The circuit supporting surface can be made of any insulating material such as plastic or ceramic. The non-conductive plug which carries the lead wires can itself serve as the circuit supporting medium. Similarly the circuit can be made of any suitable metal such as constantan, or a nickel-chromium alloy.

The connection of the printed circuit to the terminals of the lead wires can be effected by any known technique, e.g. soldering, welding, riveting, spinning, swaging, contact pressure, etc.

The printed circuit can be given any desired configuration.

Figs. 3 to 6 represent plan views of various possible printed circuit configurations. These configurations have the common feature of being cross-sectionally larger at the point where the lead wires are attached to the printed circuit 10. The electrical resistance of the circuit is thus higher in the middle portion, thereby avoiding heat production near the lead wires with the ensuing heat losses by conduction to these wires. Moreover it has been found that use of the "W" configuration produces "hot spots" on the

inside of the acute angles, thereby greatly adding to the ignitive heat efficiency of the circuit.

Figs. 7 and 9 illustrate additional configurations whereby an alternative path is provided for the current when the printed circuit 10 is broken by firing. Ionization from the explosion or the conductive residue from the primer charge creates an alternative conducting path across the small gap 12. The printed circuit bridge in these two cases, is designed to create one or two hot spots by having constrictions in the configuration. The number of these constrictions can easily be varied.

Figs. 8 and 10 illustrate configurations wherein the small gap 13 is joined by a composition such as aluminum paint which presents a high resistance at room temperature but which becomes a good conductor when the circuit bridge is burnt by the ignited primer.

An inexpensive alternate current path is thus provided irrespective of whether the fine bridge wire be ruptured or not. Such an alternate path improves the firing characteristics of a series of detonators.

The embodiments of the invention in which an exclusive property of privilege is claimed are defined as follows:

1. A new and improved electric blasting cap comprising essentially in combination, a cup-shaped metallic shell; a compressed explosive charge disposed within the bottom portion of said shell to provide detonation; an ignition assembly supported by the top portion of said shell and consisting of a printed circuit bridge positioned between and connected to two lead wires running through a flexible non-conductive plug around which the top portion of said shell is crimped securely; and an ignitable composition in intimate contact with said printed circuit bridge.

2. A new and improved electric blasting cap as claimed in Claim 1, wherein a priming charge is disposed immediately above said explosive charge.

3. A new and improved electric blasting cap as claimed in Claim 1, wherein a delay element is positioned between said ignitable composition and said explosive charge.

4. A new and improved electric blasting cap as claimed in Claim 2 wherein a delay element is positioned between said ignitable composition and said priming charge.

5. A new and improved electric blasting cap as claimed in Claim 1 wherein the printed circuit is mounted on said non-conductive plug.

6. A new and improved electric blasting cap as claimed in Claim 1, wherein the printed circuit is provided with an alternate path with a spaced gap positioned therein.

7. A new and improved electric blasting cap as claimed in Claims 1 and 6, wherein said gap is filled with an ignitable composition.

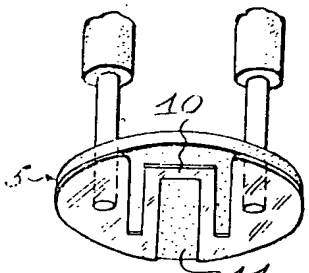

FIG.2

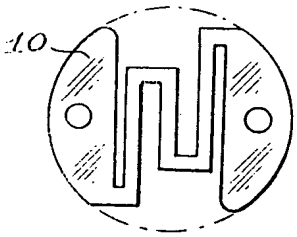

FIG.3

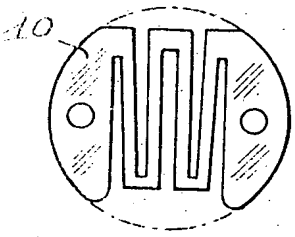

FIG.4

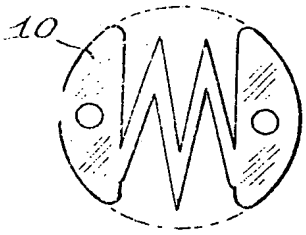

FIG.5

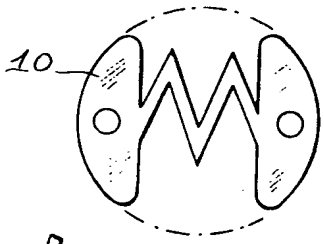

FIG.6

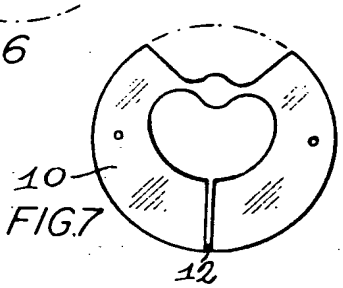

FIG.7

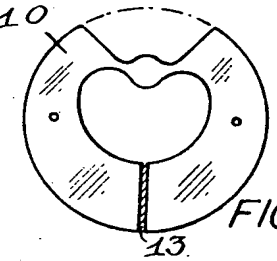

FIG.8

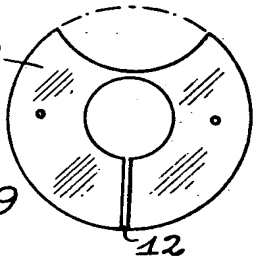

FIG.9

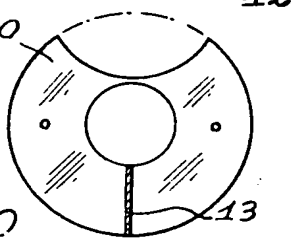

FIG.10

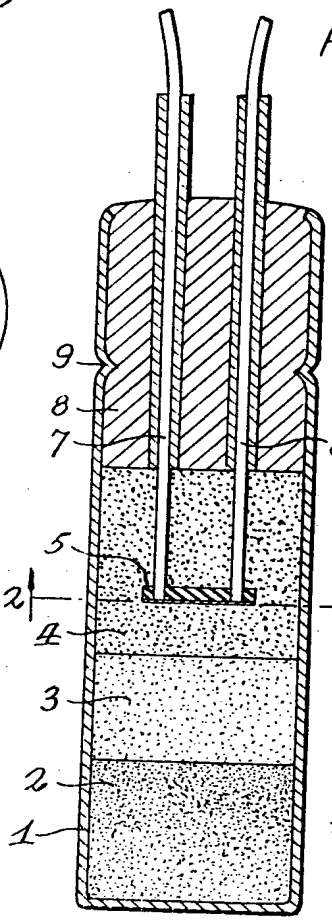

FIG.1

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